Effect of duck diet supplemented with fermented seaweed wastes on carcass

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Effect of duck diet supplemented with fermented seaweed wastes on carcass characteristics and production efficiency of indigenous Indonesian ducks

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ABSTRACT

Gracilaria sp is as eaweed with carbohydrate-rich wastes. Its symbiont, *Brotia sp*,is rich in calcium and protein. The effects of Gracilaria's wastes (GW) as formulated feed supplement on carcass characteristics and production efficiency of local Indonesian ducks. Data were collected from 120 ducks fed either a basal dietor a fermented Gracilaria's wastes supplemented diet (FGW). Treatment levels of FGW were 10%, 12.5%, and 15%. The highest level of meat antioxidant status was reached at 15% FGW, while the optimum level of FGW for decreasing the fat content was 12.5%. The best reduction in meat fat mass was at 15% FGW. Further more, duck feed with FGW resulted in lower average and normalized costs and increased income than observed with the basal diet. Thus, GW as a feed supplement effectively ameliorated the productivity and carcass quality of indigenous Indonesian ducks.

Key words: Carcass, Duck, Gracilaria's wastes, Production efficiency.

INTRODUCTION

Duck production plays an important role in the agribusiness of many Asian countries (Adzitey and Adzitey, 2011). Currently,the Southeast Asian country of Indonesia has a population of more than 44 million ducks.Duck meat has become a popular food there, resulting in an increased demand (General Directory of Animal Husbandry, 2013). The duck variety commonly cultivated by the farmers isthe indigenous Indonesian Pengging duck (*Anasjavanica*). It is a dual-purpose poultry species,with a high yield of both eggs and meat (Rokhani, 2011). People who prioritize healthy lifestyle prefer good quality duck meat and meat quality is generally determined by the muscle/fat ratio (Alonso *et al.*, 2013). It is considered healthier when the muscle content is greater than the quantity of fat. Meanwhile, fat and muscle content in the meatare influenced by the nutrient level and utilization efficiency of various feed ingredients. As a result, improving the feed is a key method to increase meat production and enhance its quality.

An unconventional way of improving the diet quality of farm animals is the use of waste materials. Using waste as a component of the feed is a wise alternative, as it not only has an economic value, but can also reduce contamination ofthe environment. As a feed stuff, waste is generally associated with low price but poor quality. Therefore, a few factors must be considered before it is used as feed.These include availability, continuity of procurement, nutrient content, and the possibility of harmful contaminants like toxins.Another consideration is whether the waste requires processing or not.

Indonesia being a large maritime nation, seaweed wastes (SW) are very abundant.They are a side effect of extensive seaweed cultivation throughout the Indonesian sea. The waste from one such seaweed,*Gracilaria sp*,is particularly rich in carbohydrates (Alamsjah and Prayoga, 2014). In addition, *Brotia sp*, a type of Southeast Asian freshwater snail that lives as Gracilaria's symbiont, is often considered rich in calcium and protein (Alamsjah and Prayoga, 2014). Therefore, Glacilaria's wastes (GW) are also potential feed supplement,with likely effects on either the performance or the meat quality of farm animals. However,their use as feed has never been reported. Meanwhile,the current uses of SWare limited;they serve as organic fertilizers post-fermentation and as medium for *Gracilibacillus* bacteria to produce alginate lyase, an enzyme for degrading alginatein wakame to oligosaccharides (Tang *et al.*, 2009). Moreover, SWas floating residue have excellent prospects for the production of bioethanol through fermentation using *Saccharomyces cerevisiae* (Ge *et al.*, 2011).Thus, investigating the potency of GW as an efficient feed supplement is a crucial step towards enhancing the performance and meat quality of farm animals.

The aim of this study was to elucidate the effects of GW,which were formulated as a feed supplement, on the carcass characteristics and production efficiency of Indonesian local ducks, to determine whether the disposal

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of SW could be leveraged as a new dietary source for the production of high-quality duck meat.

MATERIALS AND METHODS

Preparation of diet: GW were collected as a by-product of *Gracilaria sp* cultivation along coastal areas (Randu Sanga Village, District Brebes, Central Java Province). After removing the roots, GW were dried under sunlight, powdered and fermented. Before being formulated into the experimental diets, nutrient values of both, fermented GW(FGW) and non-fermented GW(NFGW), were determined by proximate analysis (Table 1). Fermentation was performed aerobically using *Aspergillus niger* (AN)in a GW/AN ratio of 1000:12. The detailed fermentation process is illustrated in Figure 1.

Preparation of animals: The study was carried out according to the guidelines for applied nutrition experiments in poultry (Reddy, 2001). Starting batch of 120 5-weeks-old Pengging ducks, with an average body weight of 734.25±0.52 g, were maintained until they were 12-weeks-old. The animals were housed in a 20-unit postal cage under standard conditions,with four individuals per unit. The ducks were given *ad libitum* feed 3 times a day,containing 2,800 kcal of energy and 18% crude protein as described in Table 2. The duration of the experiment was 49 d. Individuals were chosen by a completely randomized design and divided into four treatment groups with six replicates each: T_0 (basal diet), T_1 (10% FGW), T_2 (12.5% FGW) and T_3 (15% FGW).

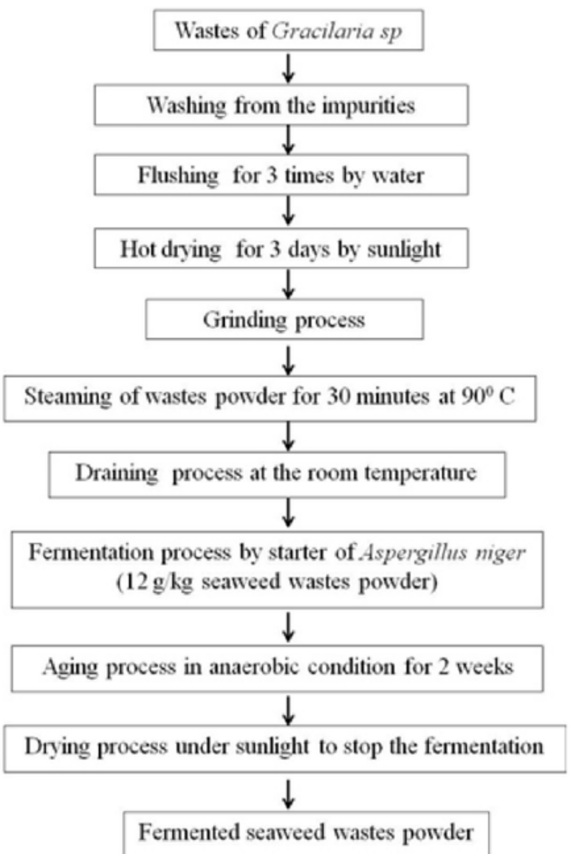

Fig 1: Flowchart diagram of GW fermentation process

Measured traits: Duck mortality was zero during the experiment. At day 49, prior to slaughtering, the ducks were weighed, and deprived of feed for 6 h.The slaughtering was performed in a commercial slaughterhouse. The carcasses were prepared by removing the skin, feet, reproductive organs, and digestive tract (Wang *et al*., 2004).Abdominal fat was separated from the carcass, and weighed. Carcass production was measured by weighing bone and meat and the bone/meat ratio was calculated. Leg meat was collected from the carcass 24 h post-mortem and was immediately frozen at “20°C for analysis.

Analytical determination: Duck meat protein content was analysed by the Kjeldahl method (AOAC, 1999). The meat sample (5 g) was briefly suspended in distilled water. The sample suspension was then transferred into a Kjeldahl flask, followed by the addition of 3 g CuSO4/K2SO4 mixture (1:9; w/w) and 20 mL of concentrated H_2SO_4. The Kjedahl flask was heated until the solution turned white in colour and then cooled. Before the distillation step, three drops of the indicator phenolphthalein were added to the sample solution. The distillate was added with 50 mL of 2% boric acid solution, 5 drops of Tashiro indicator, and NaOH until the solution became alkaline. The solution was then titrated with 0.1N HCl until it turned pink in colour.Meat protein mass was calculated by multiple meat weight with protein level.

Fat content was determined by the Soxhlet method (AOAC, 1999). Pieces of filter paper (11.7 × 14.5 cm) were oven-dried at 100–105°C for 1 h. This was followed by cooling them in a desiccator for 15 min, after which they were weighed. A sample was weighed and placed in the middle of a filter paper piece, which was then folded. The samples in filter paper were oven-dried at 100–105°C for 4–6 h, weighed, then repeatedly dried until a constant weight

Table 1: Nutrient composition of Gracilaria’s wastes

Nutrient	NF	F	Alteration (%)
Ash (%)	14.91	15.79	0.89
Crude Fat (%)	3.87	11.49	7.62
Crude Fiber (%)	14.28	12.31	-1.98
Crude Protein (%)	6.99	11.46	4.48
NFE	48.82	36.67	-12.16
Water (%)	11.13	12.28	1.15
EM (kcal/kg)	2,392.67	2,728.67	336.00

NFE : Nitrogen Free Extract
EM : Energy Metabolism
F : Fermented
NF : Non Fermented

Table 2: Ingredients and compotition of the experimental diets

Feed Stuff	***Gracilaria's wastes* (% of diet)**			
	T_0	**T_1**	**T_2**	**T_3**
Corn	56.00	48.68	46.79	44.21
Fermented *Gracilaria's* wastes	0.00	10.00	12.50	15.00
Brotiacostula	1.00	1.00	1.00	1.00
Soybean meal	20.30	19.80	19.80	19.80
Oil	1.00	1.00	1.00	1.00
Bran	14.73	12.55	12.00	12.14
Fish Meal	5.12	5.12	5.06	5.00
Lime	1.00	1.00	1.00	1.00
Premix	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
Nutrition content				
Energy Metabolism (kcal/kg)	2903.25	2900.00	2914.10	2900.17
Crude Protein (%)	20.03	20.04	20.02	20.00
Crude Fat (%)	4.80	3.92	3.96	3.98
Crude Fiber (%)	5.73	8.84	8.13	9.04
Methionin (%)	0.72	0.61	0.60	0.60
Lysine (%)	1.69	1.39	1.36	1.27
Arginine (%)	1.28	1.18	1.16	1.14
Ca (%)	1.48	1.06	1.29	1.16
P (%)	0.70	0.65	0.61	0.62

$T_0 - T_4$:Treatment with FGW
T_0 : basal diet
$T_{1,2 \text{ and } 3}$:10% FGW, 12.5% FGW, and 15% FGW, respectively
Energy Metabolism (EM) was measured based on the Balton formula according to Anggorodi (1994)
Nitrogen Free Extract = 100 – (%Water + %Ash + %Crude Protein + %Crude Fat + %Crude Fiber)
Energy Metabolism (EM) = 40.81 {0.87 (Crude Protein + 2,25Crude Fat + Nitrogen Free Extract + 4.9}

was obtained. Thereafter, the samples were placed in the desiccator for 15 min, and then weighed. Next, the samples were inserted into the Soxhlet apparatus, which had fat solvents at approximately 2.5–3 times the volume of the extraction flask. After approximately 6 h, the samples were removed from the apparatus and aerated for about 30 min in open air. They were then reinserted into the oven for approximately 1 h, placed in a desiccator for 15 min and weighed again. The weight was considered constant when the difference did not exceed 0.2 mg. Meat fat mass was calculated by multiple meat weight with fat level.

The percentage antioxidant activity (AA%) of duck meat was assessed using the DPPH free radical assay (Mensor *et al.*, 2001; Fasseas *et al.*, 2008). The samples were reacted with the stable DPPH radical in an ethanol solution. The reaction mixture consisted of 0.5 mL of the sample, 3 mL of absolute ethanol, and 0.3 mL of DPPH radical solution in 0.5 mM ethanol. When DPPH reacts with an antioxidant compound, which can donate hydrogen, it is reduced. The changes in colour (from deep violet to light yellow) were recorded as the absorbance (Abs) at 517 nm, after 100 min of reaction, using a UV VIS spectrophotometer (DU 800; Beckman Coulter, Fullerton, CA, USA). A mixture of ethanol (3.3 mL) and the sample (0.5 mL) served as the blank. The control solution was prepared by mixing ethanol (3.5 mL) and DPPH radical solution (0.3 mL). The scavenging activity percentage (AA%) was determined according to Mensor *et al*. (2001).

Production efficiency was determined by recording the data for feed cost, feed intake, average daily gain (ADG), and duck selling price,and using it for calculating the following parameters: feed cost average (FCA), feed cost per gain (FC/G) and income over feed cost (IOFC). In this study, the selling price average (SPA) was IDR 40,000.00 per duck. IOFC value is calculated as SP Aminus FCA.

Statistical analysis: One-way ANOVA was used to identify the effect of different FGW levels. For post-hoc multiple comparisons of group differences,Duncan's multiple range testwas used. Statistical analyses were performed using the software package SPSS for Windows (IBM SPSS 64 Bit Version). A value of $P < 0.05$ was considered statically significant (Dawson and Trap, 2001).

RESULTS AND DISCUSSION

As per our knowledge, this is the first study to demonstrate the potency of GW as feed stuff, influencing both meat qualityand production efficiency. By using the indigenous IndonesianPengging duck, we evaluated the effects of different percentages of FGW as feed supplement in duck diet. Meat characteristics (carcass weight, meat/bone ratio, meat protein mass, meat fat mass, abdominal fat, total fat mass, and antioxidant status) and the ration cost, as a representative of production efficiency (FCA, FC/G and IOFC), were studied. Supplementation of FGW in duck diet showed no significant effecton final weight, carcass weight, and meat/bone ratio of Pengging duck (Table 3). It indicates that GW are potentially an alternative natural source for duck dietasthere was no detrimental effect of GWonduck productivity.

Like otherSW species, GW showed enhanced nutrient content uponintervention through fermentation. As indicated in Table 1, the levels of crude fat, crude protein, and energy in FGW were higher than NFGW, along with a slight increase in ash and water content. In contrast, crude fibre and NFE decreased due to fermentation, indicating that FGW had better digestibility than NFGW. Together, the results suggest that GW could be a potential source of digestible crude fibre for farm animals.

Nowadays, many people prefer duck meat to chicken meat, due to the higher fat content in duck meat (Ali *et al*., 2007). Many reports have stated that unsaturated fatty acidsare the major component of total fat in duck meat (Cobos *et al*., 2000; Baeza *et al*., 2000; Baeza *et al*., 2002). Thismakes duck meat a source of healthy fat, suitable for daily human diet. Interestingly, using GW as feed additive not only resulted in a substantial increase in animal productivity, but also in the animal product quality. The data demonstrate that FGW supplementation in the diet significantly altered some of the carcass characteristics, i.e., meat fat mass, abdominal fat, antioxidant status, and total fat mass (Table 3). The highest level of meat antioxidant status was achieved at the highest level of FGWin experimental diet (15% FGW), while the optimum level of FGW for significantly decreasing abdominal and total fat mass is 12.5% of the experimental diet. Although at this optimum level, the meat protein content is also slightly affected, it should not have a meaningful impact on the meat nutrition value.This is because the recommended daily protein in take for the normal human weight range is equivalent to only 63 g of cooked duckling, based on data from the USDA nutrient database. Mean while, the greatest reduction in the meat fat mass was achieved at the highest concentration (15% FGW). Thus, all data suggest that utilization of GW as feed additive in duck diet ameliorated the quality of carcass.

It is generally believed that the quality of feed affects the chemical composition of meat fat. Feed enriched with crude fibre originating from plants can reduce the absorption of glucose in the intestinal tract. This lowers the blood insulin level,leading toan increased level of glucagon and triggering lipolysis in the tissues (Reimer *et al*., 2012).The chlorophyll content of GW is a likely explanation for the increased antioxidant status of duck meat (Sayed *et al*., 2013). However, the mechanisms behind the effects of GW,for example, with respect to hormone activity,warrant further investigation.

In addition,we showed the potential of GW as a good feed stuff through improvementin the production efficiency, via ration cost analysis (Table 4). Compared with the basal diet, duck feed supplemented with FGW had a lowering effect on FCA and FC/G. On the contrary, IOFC values tended to increase with FGW supplementation. By evaluating IOFC, one can gauge the additional income that can be generated over the cost of feed. As feed costs constitute the largest expense in a duck cultivation operation, estimates of these costs allow a farmer to make prudent decisions (Frobose *et al*., 2014). In addition, calculation of IOFC can help to identify the performance improvements

Table 3 : Carcass characteristics (means ± STDEV) of ducks fed experimental diets

Parameter	FGW (% of diet)			
	T_0	T_1	T_2	T_3
Final weight, g	1369.40 ± 60.34	1328.60 ± 56.12	1260.00 ± 65.11	1302.20 ± 44.56
Carcass weight, g	782.80 ± 8.56	723,80 ± 7.89	714.60 ± 6.76	736.60 ± 8.54
Meat/ bone ratio, g/g	2.20 ± 0.02	2.07 ± 0.01	2.01 ± 0.07	2.23 ± 0.03
Meat protein mass, g	78.01 ± 0.32^a	73.63 ± 0.28^b	74.71 ± 0.51^b	78.08 ± 0.71^a
Meat fat mass, g	9.73± 0.05^b	10.69± 0.09^a	7.16± 0.03^c	6.88± 0.04^c
Abdominal fat, g	12.05± 0.08^a	9.43± 0.04^b	6.17± 0.02^c	9.24± 0.11^b
Total fat mass, g	21.78± 0.13^a	20.12± 0.17^a	13.33 ± 0.14^c	16.12 ± 0.21^b
Antioxidant status, ppm	2.92± 0.06^c	3.04± 0.02^c	5.08± 0.02^b	6.57 ± 0.07^a

$^{a, b, c,}$ Means in the same row with different superscripts differ significantly ($P < 0.05$) according to Duncan's multiple-range test

FGW : Fermented *Gracilaria's*wastes

$T_0 - T_4$:Treatment with FGW

T_0 : basal diet

$T_{1,2, \text{and } 3}$: 10% FGW, 12.5% FGW, 15% FGW, respectively

Table 4: Ration cost evaluation of local ducks fed experimental diets

Parameter	**IDR**			
	$\mathbf{T_0}$	$\mathbf{T_1}$	$\mathbf{T_2}$	$\mathbf{T_3}$
Feed cost average	39,483.48	38,679.94	37,431.55	37,937.62
Feed cost per gain	6,580.58	6,446.66	6,238.59	6,322.94
Income over feed cost	516.52	1,320.06	2,568.45	2,062.38

$T_0 - T_4$:Treatment with FGW
T_0 : basal diet
$T_{1,2,\text{ and }3}$: 10% FGW, 12.5% FGW, 15% FGW, respectively
IDR : Indonesian Rupiah

needed to make an initial investment profitable. To ensure that IOFC is being utilized to its fullest advantage,it must be factored into feed production and supplement purchasing decisions (Poon and Weersink, 2011).

It was concluded that GW as feed supplement effectively ameliorated the productivity and carcass quality of an indigenous Indonesian duck. It is expected that the utilization of GW, one of the floating residues, could ultimately increase the quality of healthy meat as a protein source.

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